above and yet have found nothing more about this new species. Has not H. B. Brady's paper, "On some Foraminifera from the Loochoo Islands" (*Proc.* R.I.Ac., vol. ii. n.s. p. 589) been overlooked by the recorder of the Protozoa? Perhaps Ross, F. O., "Myology of the Cheetah" (*Felis jubata*), in the same *Proceedings*, vol. iii. n.s., part 3, August, 1877, was also worthy of a reference. Other papers are quoted from these same *Proceedings*, which it is true contain little that is zoological. Without a wish to start a controversy as to the reproducing the Greek κ by the English *c*, we venture to think that a little discretion might be allowed to authors in this matter.

In concluding this notice we thank, in common with all zoologists, the editor for the volume he has published, and we wish a long and prosperous life to the association of which he is the officer, an association which deserves every possible assistance from those interested in the subject of zoology.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Sunshine Cycles

PROF. PIAZZI SMYTH in his letter headed as above to NATURE (vol. xxi. p. 248) has given us the latest information regarding those variations of temperature indicated by the Edinburgh earth thermometers, commonly termed "waves of heat and cold." He has, however, cited but one case in which an extraordinary amount of sunshine was actually observed to occur simultaneously with the crest of a heat-wave, viz., in 1826.

Having lately been engaged upon a comparison of the annual and seasonal amounts of cloud in different parts of Europe, I think I can bring forward some evidence to show that these waves of heat and cold are indeed veritable cycles of sunshine and gloom.

Before proceeding to give proofs of this statement, however, it will be necessary to consider for a few moments the effects that most probably attend a prevalence of cloud or the reverse at different seasons of the year. It is, I imagine, pretty generally allowed that presence of cloud in the summer is associated with coolness and in the winter with warmth; and in like manner that clear skies which in the summer by promoting solar radiation favour the development of great heat, in the winter by giving free scope to terrestrial radiation (in the then comparatively reduced stage of solar radiation) tend to produce excessive cold.

A warm year need not therefore be a *very* cloudless year, provided the majority of its cloud occurs during the cooler months. In like manner a cold year need not be *very* cloudy, provided its clear sunshiny days occur mostly in the winter, or when the solar altitude is small.

It must, however, be noted that the effects of the presence or absence of cloud are not of equal *magnitude* at the summer and winter solstices respectively. At and near the former epoch the temperature of the extra-tropics is more dependent on the direct solar rays, and anything which intercepts these produces a more marked effect than at the latter epoch, when the prevailing direction of the wind becomes the predominating factor.

If, then, any general relation with respect to cloudiness be visible in the mean annual results, at the epochs of greatest heat and cold as given by Prof. Smyth, the results for the summer seasons alone, should exhibit the *same* relation but in a more marked degree.

The following tables have been prepared from the limited data at my disposal, with especial reference to the foregoing considerations.

They comprise the following observations:—

1. The relative monthly and annual mean cloud proportions at Greenwich from 1841 to 1876, and at Oxford from 1850 to 1875, as supplied to me by Mr. Whipple, of the Kew Observatory.

2. Do. at Munich from 1843 to 1866, as summarised by Dr. J. Lamont in the "Monatliche und jährliche Resultate der an der königlichen Sternwarte bei München von 1843 bis 1866 angestellten meteorologischen Beobachtungen."

3. Do. at Breslau, as given by Dr. J. Galle in a similar work.

4. The results of the tri daily observations at Leipzig from 1830 to 1859, and for the summer months at Münster from 1858 to 1874 ("Ueber die Beziehungen der Sonnenfleckenperiode zu meteorologischen Erscheinungen," von Dr. F. G. Hahn. Leipzig, 1877, pp. 123-126).

5. The annual number of cloudy days (giorni nuvoli) at Bologna from 1814 to 1858 ("Notizie sul clima Bolognese, etc., nel quaranta cinquennio 1814–1858," by Prof. L. Respighi).

6. The number of days on which Schwabe was unable to observe the sun at Dessau in each year, from 1826 to 1859.

7. The number of days on which neither Prof. Wolf nor his assistant could observe the sun at Zurich from 1859 to 1877 ("Ueber die Beziehungen der Sonnenfleckenperiode zu den met. und mag. Erscheinungen der Erde," von H. Fritz. Haarlem, 1878, p. 212).

The figures in every case denote the difference from the corresponding mean, but those for Greenwich, Oxford, Munich, and Breslau only, are intercomparable.[1]

TABLE I.—*Mean Annual Cloud.*

Piazzi Smyth's dates for the crests of heat-waves.	Years.	Greenwich.	Oxford.	Munich.	Breslau.	Bologna. diff. from yearly mean.	Leipzig. diff. from yearly mean.
1826·5	1826	—	—	—	—	− 2	—
1834·5	1834	—	—	—	—	−38	− 78
1846·4	1846	+0·2	—	−0·43	—	+18	− 21
1857·9	1857	−0·1	−0·2	−0·03	−0·8	− 5	−151
1868·8	1868	−0·6	−0·2	—	−0·1	—	—
Means ...	...	−0·1	−0·2	−0·25	−0·4	− 6	− 83
Dates for the crests of cold-waves.							
1829·6	1829	—	—	—	—	+ 8	+ 45
1837·3	1837	—	—	—	—	−17	+ 37
1845·2	1845	−0·1	—	+0·10	—	+10	+ 9
1848·0	1848	+0·2	—	−0·23	—	+ 8	+ 16
1855·8	1855	+0·3	+0·2	+0·50	±0·0	+13	+ 2
1860·3	1860	+0·6	+0·7	+0·70	+0·6	—	—
1866·3	1866	+0·3	±0·0	−0·10	+0·1	—	—
1870·3	1870	−0·6	−0·5	—	±0·0	—	—
1879·1	—	—	—	—	—	—	—
Means ...	...	+0·1	+0·1	+0·1	+0·1	+ 5	+ 21

TABLE II.—*Summer Cloud.*

Years.	Greenwich.	Oxford.	Munich.	Breslau.	Leipzig.	Münster.
1826	—	—	—	—	—	—
1834	—	—	—	—	−16	—
1846	−0·38	—	−1·35	−0·8	−15	—
1857	−1·08	−0·75	−0·70	−0·5	−25	—
1868	−1·45	−0·95	—	—	—	−18
Means	−0·97	−0·85	−1·07	−0·6	−18	−18
1829	—	—	—	—	+21	—
1837	—	—	—	—	− 3	—
1845	−0·25	—	+0·25	—	− 3	—
1848	+0·59	—	±0·0	—	+21	—
1855	−0·28	+0·41	+0·15	+0·1	− 2	—
1860	+1·45	+1·71	+0·68	+0·9	—	+14
1866	+0·49	+0·38	+0·38	+0·8	—	+ 1
1870	−0·31	−0·62	—	+0·4	—	+ 9
Means	+0·28	+0·47	+0·29	+0·55	+ 6	+ 8

[1] Those for Munich and Breslau originally given on the scale of 0–4 have been converted to the ordinary scale of 0–10.

TABLE III.—*Winter Cloud.*

Years.	Greenwich.	Oxford.	Munich.	Breslau.	Sums.
1826	—	—	—	—	—
1834	—	—	—	—	—
1846	+0·12	—	−0·03	—	+0·09
1857	+0·12	−0·34	−0·53	−1·27	−2·02
1868	+0·17	+0·46	—	+0·45	+1·08
Means	+0·13	+0·03	−0·28	−0·41	—
1829	—	—	—	—	—
1837	—	—	—	—	—
1845	−0·05	—	+0·17	—	+0·12
1848	+0·25	—	−0·58	—	−0·33
1855	+0·52	+0·13	+0·47	−0·02	+1·10
1860	±0·0	+0·21	+0·52	+0·75	+1·48
1866	−0·25	−0·54	−0·33	+0·10	−1·02
1870	−0·28	−0·04	—	−0·17	−0·49
Means	+0·03	−0·06	+0·05	+0·14	—

TABLE IV.—*Number of Days on which Schwabe was unable to observe the Sun at Dessau.*

Years.		Days.	Years.		Days.
1826	... ...	88	1843	... ...	41
27	... ...	92	44	... ...	46
28	... ...	84	45	... ...	33
29	Cold wave	121	46	Hot wave	51
30	... ...	148	47	... ...	89
31	... ...	126	48	Cold wave	88
32	... ...	96	49	... ...	80
33	... ...	98	50	... ...	57
34	Hot wave	92	51	... ...	57
35	... ...	121	52	... ...	29
36	... ...	166	53	... ...	66
37	Cold wave	197	54	... ...	31
38	... ...	163	55	... ...	52
39	... ...	160	56	... ...	45
40	... ...	103	57	... ...	41
41	... ...	82	58	Hot wave	30
42	... ...	58	59	... ...	22

Days on which neither Prof. Wolf nor his Assistant could observe the Sun at Zurich.

Years.		Days.	Years.		Days.
1860	Cold wave	92	1869	... ...	101
61	... ...	81	70	Cold wave	89
62	... ...	76	71	... ...	93
63	... ...	90	72	... ...	71
64	... ...	74	73	... ...	62
65	... ...	69	74	... ...	62
66	... ...	67	75	... ...	86
67	... ...	66	76	... ...	89
68	Hot wave	92	77	... ...	58

So far as the preceding tables afford a basis for deduction, it appears that with few exceptions (1) the annual amount of cloud is *below* the mean at the epochs of the crests of the heat-waves, and *above* the same at those of the cold-waves; (2) that the relation is of the same kind, but more marked when the results for the summer season alone are compared; (3) that the results for the winter show in several cases a tendency to vary in the opposite manner.[1]

I may remark that in general the dates of the crests of the hot and cold waves, as given by Prof. Smyth, coincide with, and include, the principal critical epochs of the cloud variation.

Judging from the cloud observations *alone*, the most intense, as well as most universal waves would seem to have been the hot waves of 1857 and 1868, and the cold wave of 1860.[2]

[1] As a further addition to the evidence just given, both in favour of the secular variation and the contrary character of the two extreme seasons as to cloud, Prof. Piazzi Smyth tells me that the results of the cloud observations at Edinburgh for eighteen years show June and July, 1879 (the date of the most recent cold-wave), to have been the cloudiest months throughout the period, but December, 1879, the clearest, the year on the whole being excessively cloudy. On the other hand June and July, 1868 (a heat-wave), were the clearest ever known.

[2] It is somewhat remarkable that in Dr. Köppen's great work on the temperatures in different parts of the globe in connection with the sun-spot period, the heat-wave of 1857, as deduced from air-temperatures, appears only as a local phenomenon in the extra-tropics. The other dates, 1825·8, 1834·2, 1846·4, and 1863·7, given by Dr Köppen for the maxima of the temperature of the extra-tropics are nearly identical with those deduced from the earth-temperatures by Prof. Smyth.

It would be premature to attempt to draw any definite conclusions from the results I have exhibited, but they rather tend, I think, to dissipate the notion Prof. Smyth apparently entertains, that there is any specific difference between the waves of heat and those of cold.

It would seem indeed as though *both* were partially dependent upon watery vapour and its transformations, the heat wave being in part the *effect* of an excess of sunshine, and the cold wave of an excess of cloud.

Again, were the heat waves of more direct cosmical origin than the cold waves, they should occur more universally and more simultaneously in different parts of the world than the latter, whereas the results of most investigations into this matter point the other way. The epochs of maximum and minimum annual temperature may be respectively nearly identical for as large a district as that included by the stations employed above, but they certainly differ to some considerable extent, though at the same time in a regular and progressive manner, when the observations are made to embrace an entire hemisphere.

Thus, according to Köppen, the following are the dates of maximum and minimum air-temperature in the tropics and extra-tropics respectively:—

Köppen's epochs of maximum air-temperature. Tropics.	Extra tropics.	Piazzi Smyth's epochs of crests of heat-waves.	Wolf's dates for minimum sun-spots.
1822·5 ...	1825·8 ...	1826·5 ...	1823·3
1833·1 ...	1834·2 ...	1834·5 ...	1833·9
1842·8 ...	1846·4 ...	1846·4 ...	1843·5
1854·7 ...	— ...	1857·9 ...	1856·0
1865·1[1] ...	(1868·7) ...	1868·8 ...	1867·2

Köppen's epochs of minimum air-temperature. Tropics.	Extra-tropics.	Piazzi Smyth's epochs of crests of cold-waves.	Wolf's dates for maximum sun-spots.
1830·1 ...	1831·9 ...	1829·6 ...	1829·9
1836·4 ...	1837·8 ...	1837·3 ...	1837·2
		1845·2	
1847·6 ...	1850·3 ...	1848·0 ...	1848·1
		1855·8	
1858·4 ...	(1861·6) ...	1860·3 ...	1860·1

From the above table it is evident that *both* the heat and cold waves are retarded in the extra-tropics behind those in the tropics, the mean lag being as much as 2·9 years in the case of the former and 2·2 years in that of the latter. There is no reason, therefore, for supposing either of these phenomena in the extra-tropics to be the *direct* effects of solar or cosmical influences; but, on the contrary, there is much to favour the notion that they are both equally the indirect consequences of the corresponding elevations and depressions of temperature in the tropics.

It will be noticed that while the crests of both the hot and cold waves given by Prof. Smyth agree in the majority of cases with those given by Dr. Köppen for the extra-tropics and also with the sun-spot epochs, there are one or two cold waves, such as those of 1845, 1855, and 1866, which appear completely isolated from either of these latter, though I am not aware that they are inferior to the rest in point of magnitude. That even these waves are not of mere local occurrence, though their prototypes do not appear in the tropics, is probable, from the fact that similar ones have been noticed by Dr. F. G. Hahn to occur at Leipzig in 1845, 1855, and 1865, in the form of secondary maxima of cold corresponding to the secondary maxima in the aurora.

In the short cycle 1829-37 no secondary wave appears at Leipzig just as at Edinburgh.

Meanwhile, whatever causes be ultimately adduced to account for the appearance of these periodical waves of heat and cold, it is evident that they partially bear out the designation accorded them by Prof. Smyth, of "sunshine cycles."

February 3 E. DOUGLAS ARCHIBALD

[1] This epoch is given by Prof. S. A Hill, of Allahabad, in continuation of Dr. Köppen's work, and is deduced from observations taken in India (see "Variations of the Rainfall in Northern India," by S. A. Hill, *Indian Meteorological Memoirs*, p. 193). Great reliance cannot therefore be given to it, though at the same time it agrees very well with the result for the *sub*-tropics, as given by Dr. Köppen.